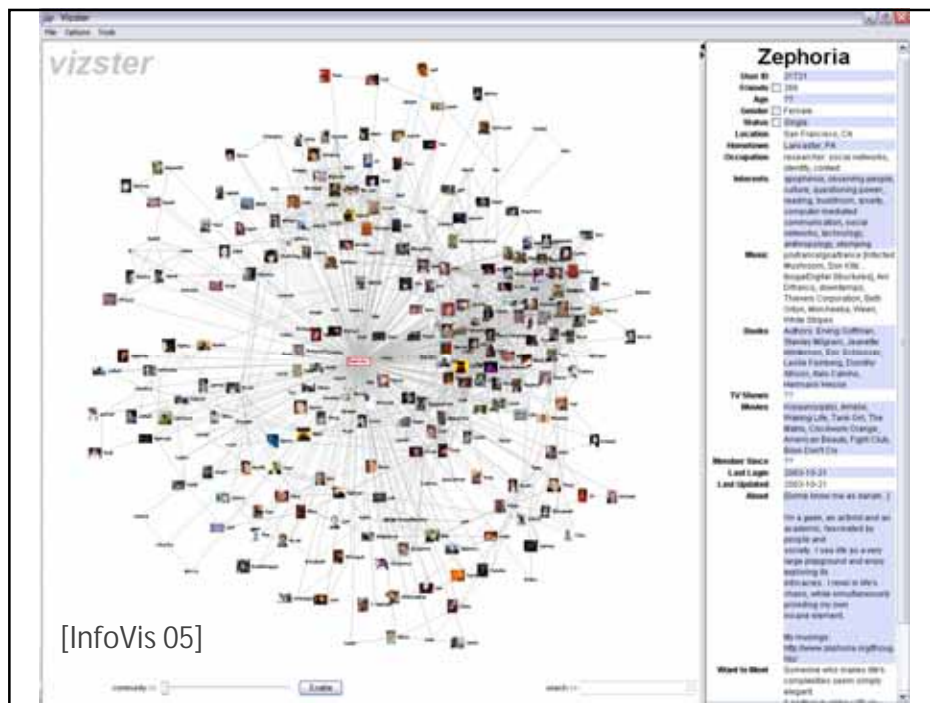


Collaborative Visual Analysis



Jeffrey Heer Stanford University
CS294-10 Visualization 17 Nov 2008

A Tale of Two Visualizations



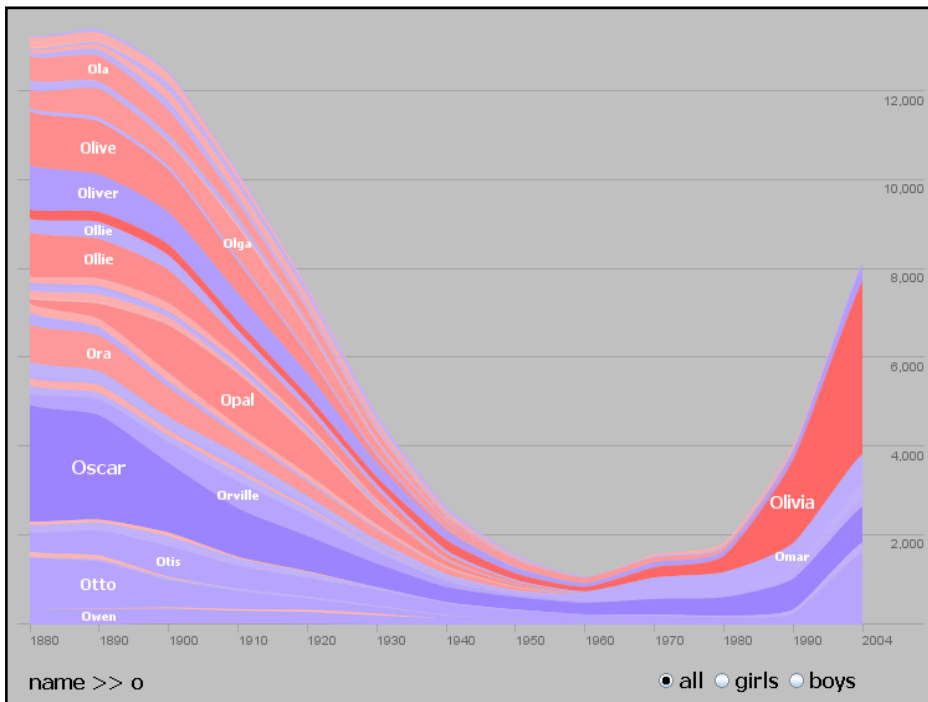
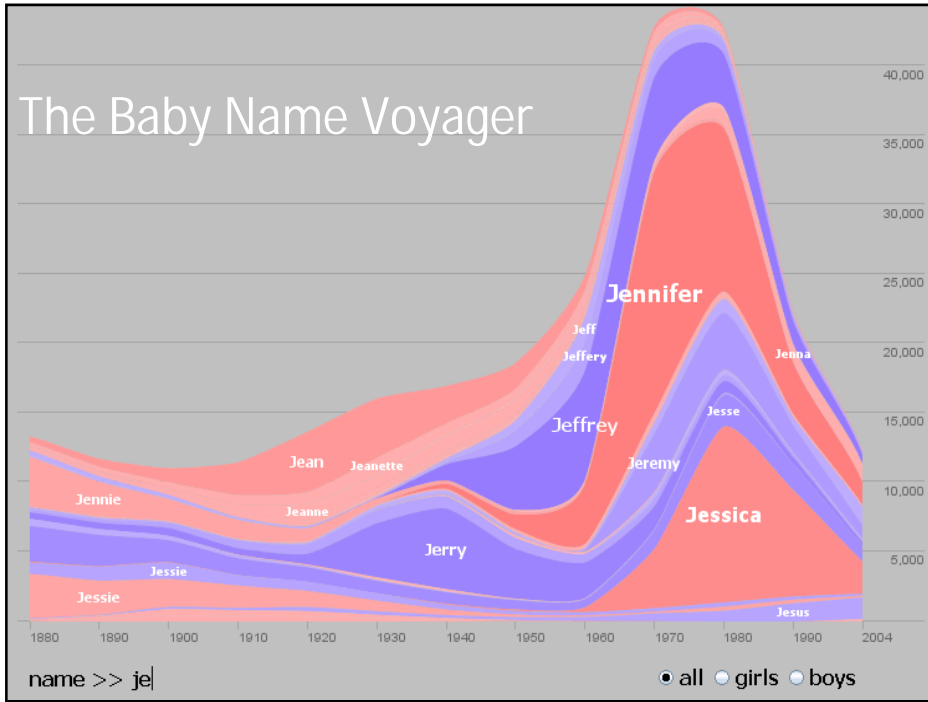
[InfoVis 05]

Observations

Groups spent more time in front of the visualization than individuals.

Friends encouraged each other to unearth relationships, probe community boundaries, and challenge reported information.

Social play resulted in informal analysis, often driven by story-telling of group histories.



Social Data Analysis

Visual sensemaking can be **social** as well as cognitive.

How can user interfaces catalyze and support **collaborative visual analysis**?

Design and evaluate both **real systems** and **targeted techniques**.

sense.us

A Web Application for Collaborative
Visualization of Demographic Data

sense.us - social data visualization - Mozilla Firefox

http://sense.us/

sense.us

Log in to add comment | In e-mail | [username] | [password] | [login help]

Dogear Tags
Dogear Tag Usage, May 2005 to August 2006
source: IBM Dogear
10 comments

Dogear People
Dogear Bookmarking by Person, May 2005 to August 2006
source: IBM Dogear
1 comment

Job Voyager
Reported Occupations of U.S. Labor Force, 1850-2000
source: <http://pums.org>
139 comments

Birthplace Voyager
Reported Birthplace of U.S. Residents, 1850-2000
source: <http://pums.org>
10 comments

sense.us - social data visualization

sense.us is a prototype system for collaborative visualization.

- See the data. See what people have to say about it.
- Dive into the data and share your explorations.

The site requires **Java 1.5+** and either **Firefox** or **Internet Explorer**. Use your **IBM W3/BluePages e-mail and password** to login. Use at least **1024x768** resolution for the best experience.

Check out the **user's guide** and **privacy policy** before getting started.

Having problems using Firefox with Java 1.4? Some users using Firefox and Java 1.4 have found that comments aren't loading properly. If you run into the problem, consider upgrading to Java 1.5 (**Windows, Linux**) or using Internet Explorer (on Windows systems). Sorry for any inconvenience!

U.S. Census State Map
State Map of 2000-2005 Census Data
source: U.S. Census Bureau
16 comments

Population Pyramid
U.S. Population Demographics, 1850-2000
source: <http://pums.org>
7 comments

[CHI 07]

Exploratory Design Rationale

Sharing within visualization and across the web

http://sense.us/jobs#scale=1&gender=All&query=mili

Reported Occupations of U.S. Labor Force, 1850-2000 (source: <http://pums.org>)

>> mili * all men women % of Work Force

comments (3) | New Comment | View All (143)

Is this military info right?

I would have expected a different pattern for the military, but then again maybe this is just the military industrial complex growing and growing.

by **Mark Sharp** on Fri Jul 21, 2006 10:05 AM

There are labels where I would have expected big jumps.

by **Mark Sharp** on Fri Jul 21, 2006 10:05 AM

well, there was also the cold war right after ww2, which might be part of the reason why there's such a huge jump after the 40s. It is also interesting that there is such a dip between the 70s and the 80s.

by **Julia Hernandez** on Fri Jul 21, 2006 11:01 AM

I guess a lot of it has turned to robots, and the industrial complex, as mark suggested, though it would be interesting to see the comparison of the fall in military personnel and to the rise in OOD funding for robots and industry.

by **Jason Wilson** on Fri Jul 21, 2006 11:01 AM

I think the jumps have more to do with the economy at large rather than any particular military conflict. Lots of money in conflict has already been spent before the conflict starts.

by **Fred Klein** on Sat Aug 12, 2006 10:24 AM

reply

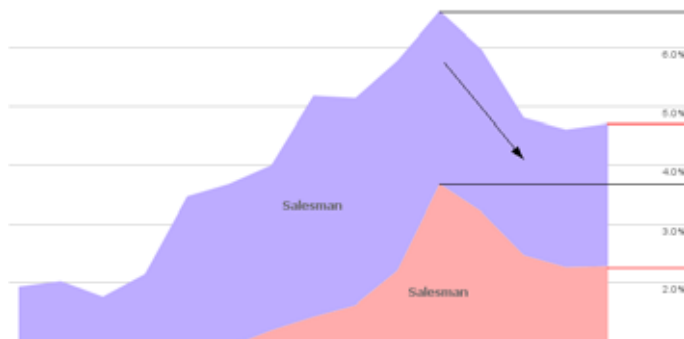
bookmarks (1) | Add View | Save | Load | View All

Exploratory Design Rationale

Sharing within visualization and across the web

Pointing at interesting trends, outliers

Annotate  Stroke  Fill  Sans-Serif ▼ 14 **B I**

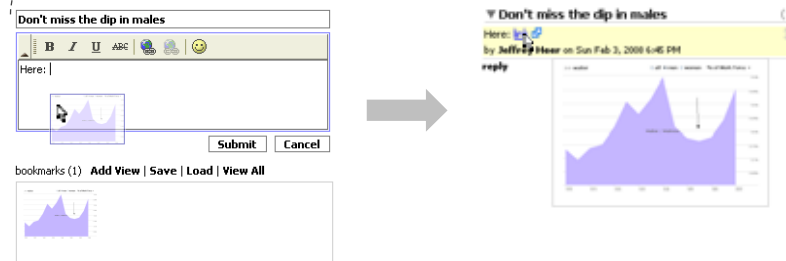


Exploratory Design Rationale

Sharing within visualization and across the web

Pointing at interesting trends, outliers

Collecting and linking related views



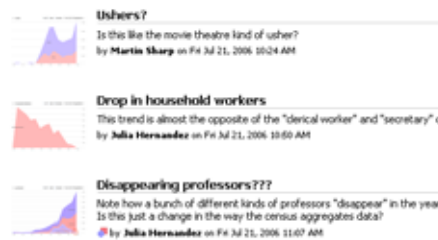
Exploratory Design Rationale

Sharing within visualization and across the web

Pointing at interesting trends, outliers

Collecting and linking related views

Awareness of social activity



Exploratory Design Rationale

Sharing within visualization and across the web

Pointing at interesting trends, outliers

Collecting and linking related views

Awareness of social activity

Don't disrupt individual exploration

User Study Design

30 participant laboratory study

25 minute, unstructured sessions with job voyager

3-week live deployment on IBM intranet

Employees logged in using intranet accounts

Data analyzed

12.5 hours of qualitative observation

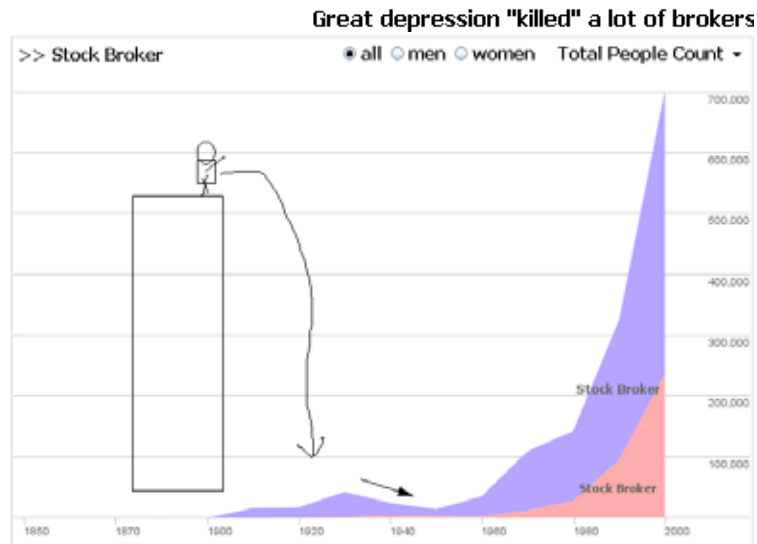
258 comments (41 pilot, 85 ibm, 60 ucb, 72 live)

Usage logs of user sessions

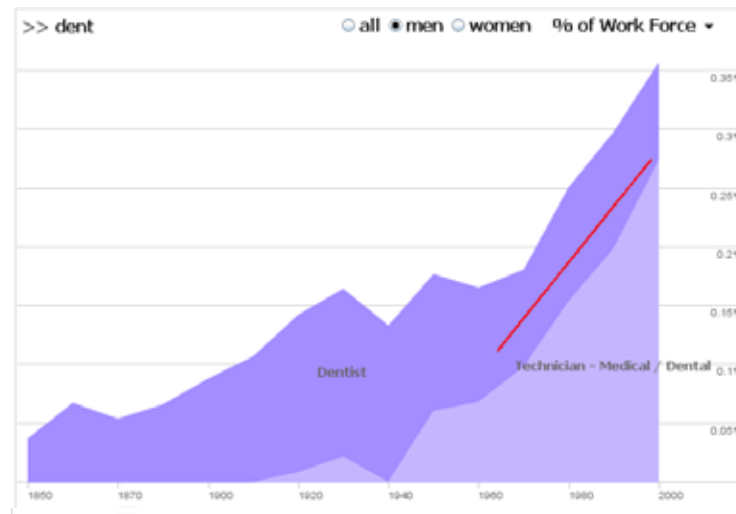
Building Off of Others



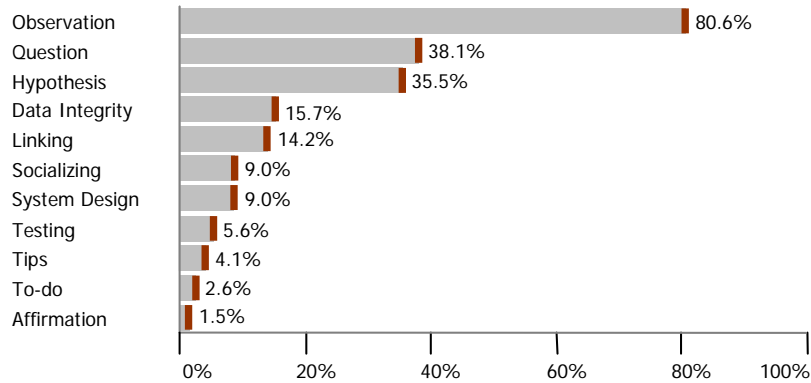
Data Jokes



Collaborative Sensemaking

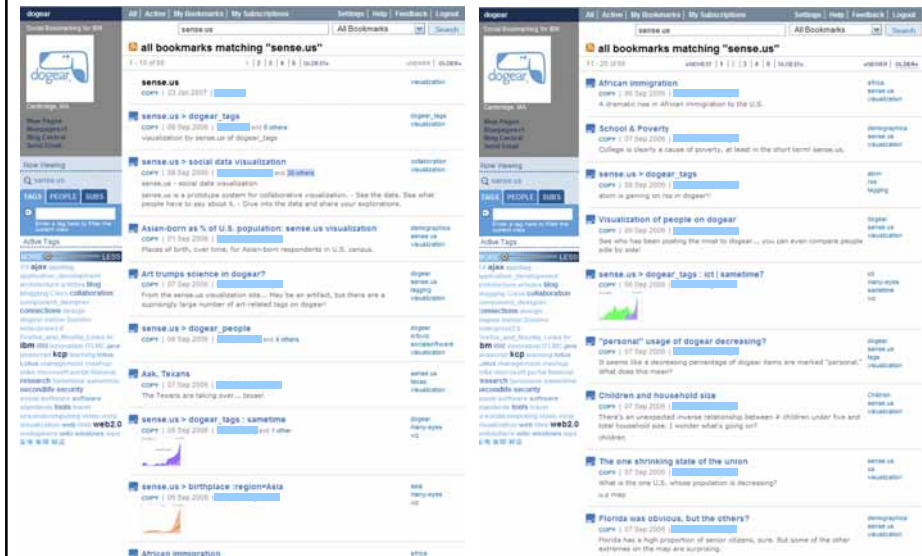


Content Analysis of Comments



Feature prevalence from content analysis (min Cohen's $\kappa = .74$)
 High co-occurrence of Observations, Questions, and Hypotheses

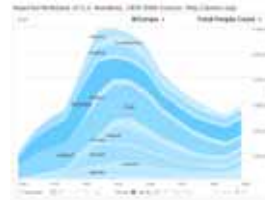
Sharing in External Media



Voyagers and Voyeurs

Complementary faces of analysis

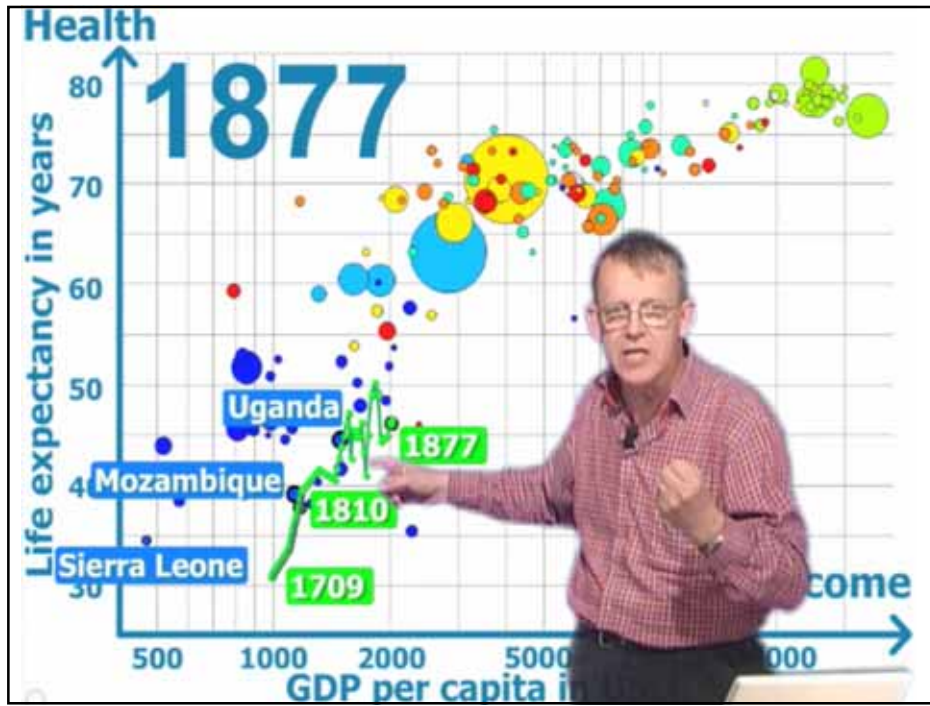
Voyager – focus on visualized data
Active engagement with the data
Serendipitous comment discovery

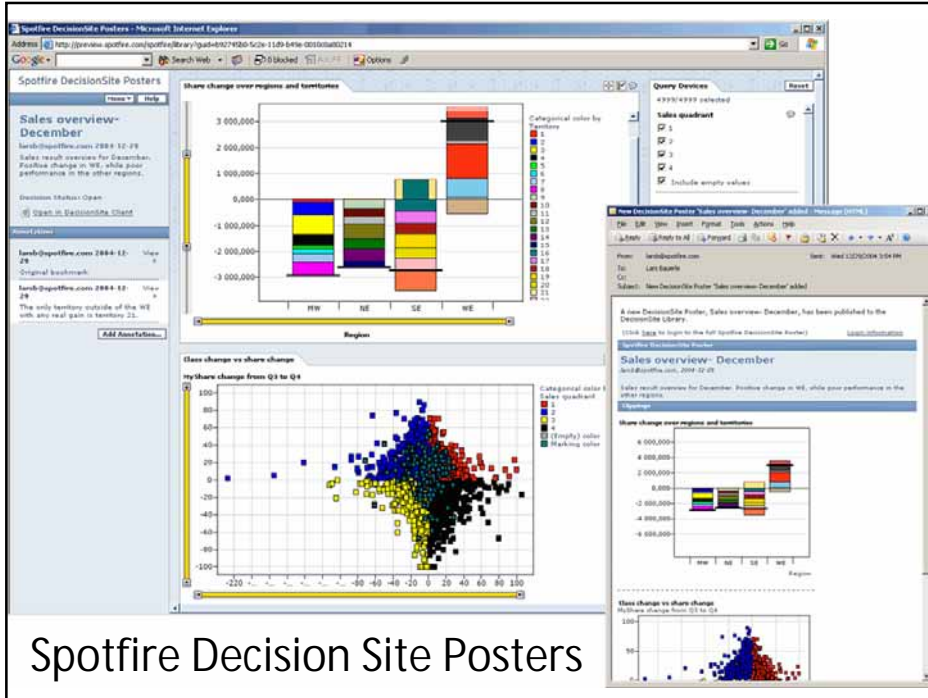


Voyeur – focus on comment listings
Investigate others' explorations
Find people and topics of interest
Catalyze new explorations

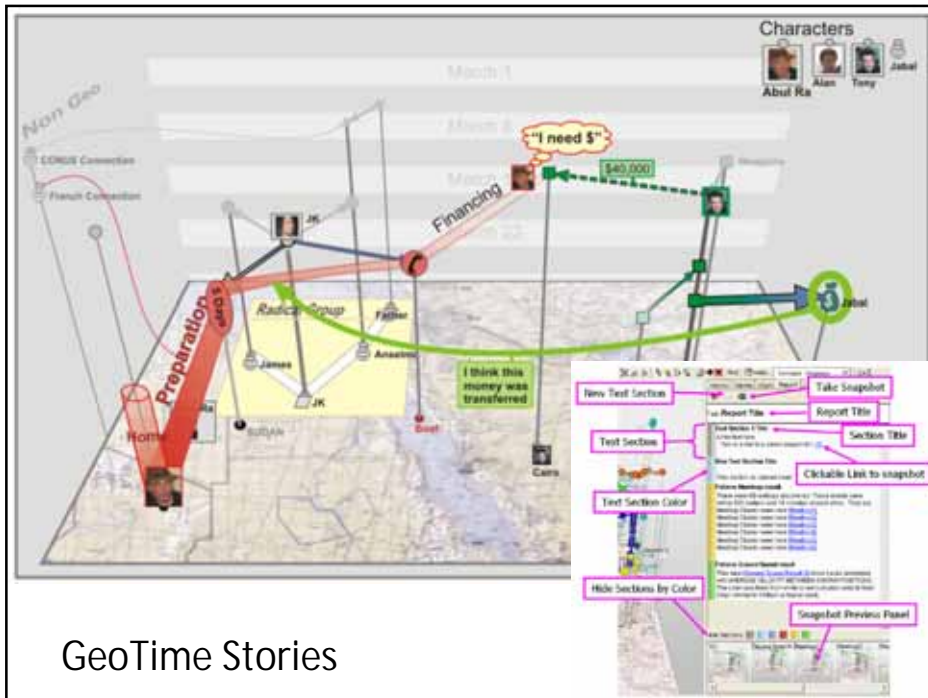


Social Data Analysis

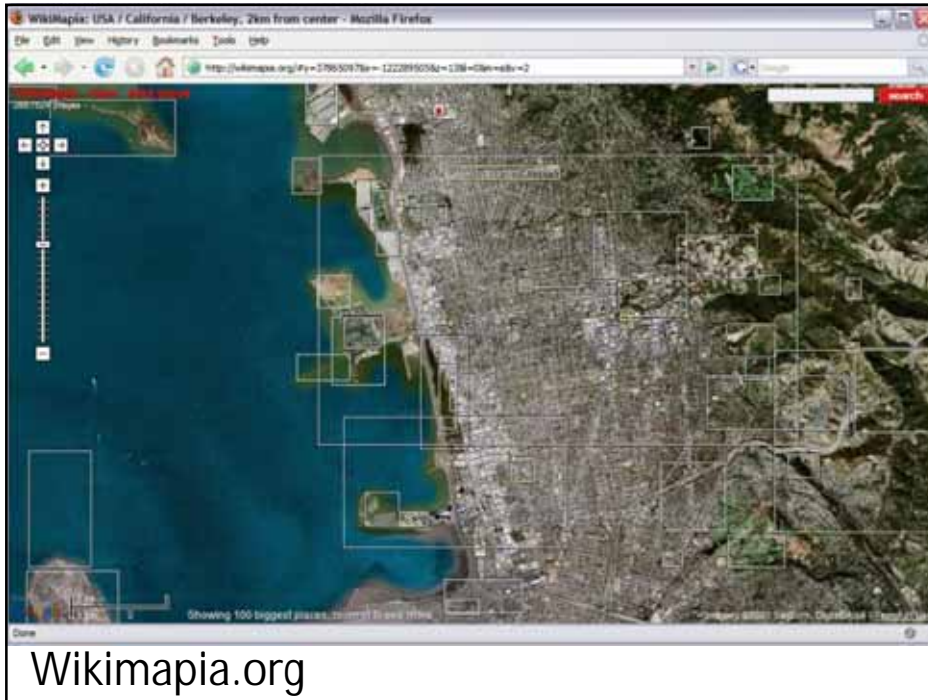




Spotfire Decision Site Posters



GeoTime Stories





Modules of Contribution

Data Management

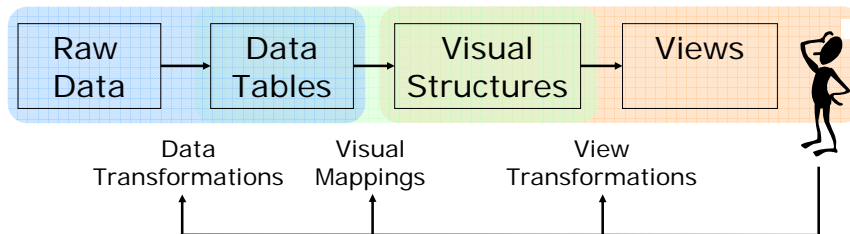
Contribute Data
Clean Data
Categorize Data
Moderate Data
Create Metadata

Visualization

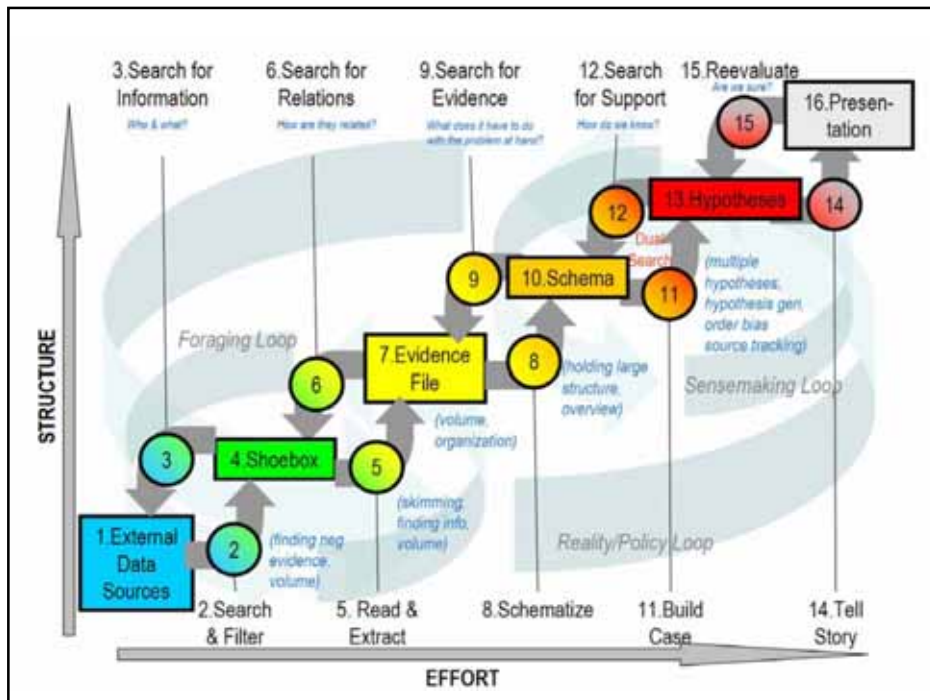
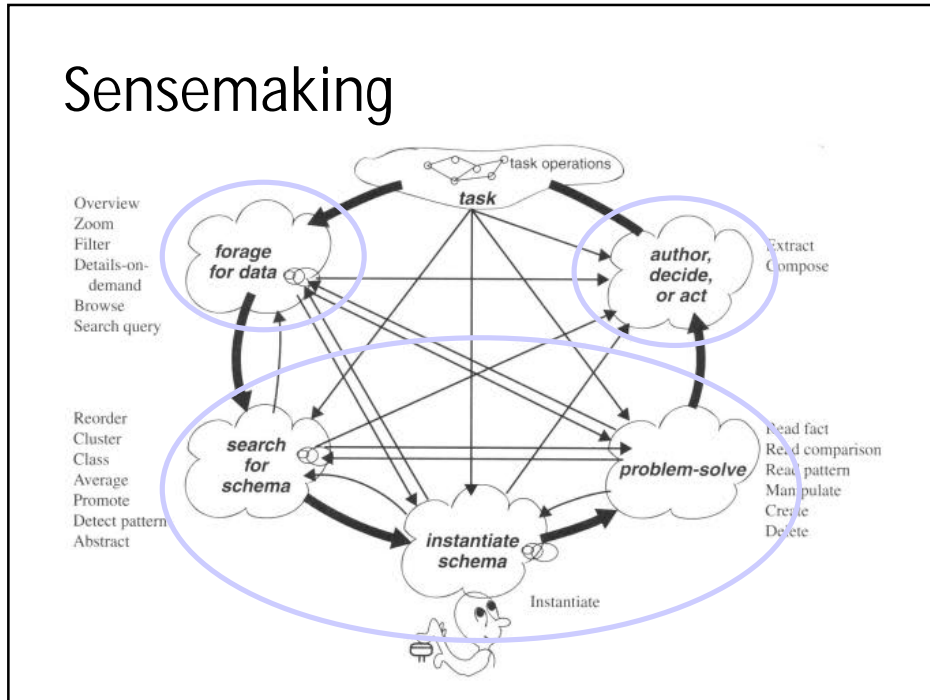
Select Data Sources
Apply Visual Encoding
Author Software

Visual Analytics

Observations
Hypotheses
Evidence (+/-)
Summarize
Report / Presentation



Sensemaking



Design Considerations [VAST 07, IVS 08]

Division, allocation, and integration of work

Common ground and awareness

Reference and deixis (pointing)

Identity, trust, and reputation

Group formation and management

Incentives and engagement

Presentation and decision-making

Social Data Analysis

How can users' **activity traces** be used to improve awareness in collaborative analysis?

Social Navigation

del.icio.us / jheer /

your bookmarks | your network | subscriptions | links for you | post

All your items (169)

< earlier | later > page 1 of 19

2005 MicroGraph Winners [edit](#) / [delete](#)
to visualization photography science ... [saved by 5 other people](#) ... on sept 20

NEJM - The Spread of Obesity in a Large Social Network over 32 Years [edit](#) / [delete](#)
to health networks research science social visualization psychology ... [saved by 20 other people](#) ... on sept 06

PetersProjection-over gif (GIF Image, 1203x800 pixels) [edit](#) / [delete](#)
to maps visualization ... [saved by 3 other people](#) ... on aug 30

Forbes Lists, World's Richest People, and more - Forbes.com [edit](#) / [delete](#)
to business data economics reference statistics ... [saved by 17 other people](#) ... on aug 25

Well-formed data | Elastic lists | Nobel prize winners demo [edit](#) / [delete](#)
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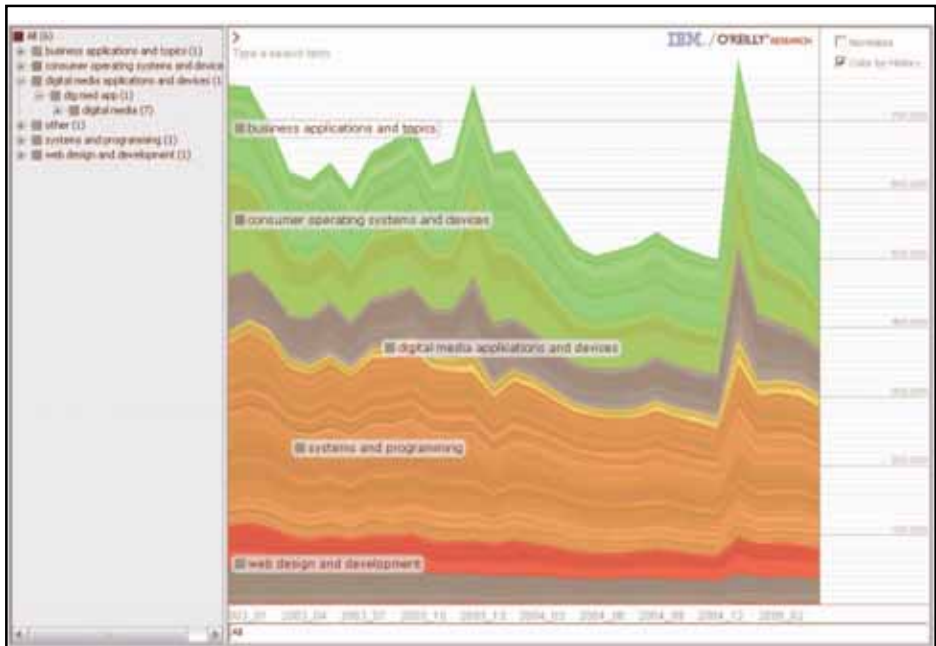
Acrobats [edit](#) / [delete](#)
to flash fun interaction animation ... [saved by 61 other people](#) ... on aug 23

Wikinvest | The Investing Wiki with Research about Companies, Investment Concepts, and mo [edit](#) / [delete](#)
to collaboration web web reference finance economics business analysis visualization ... [saved by 17 other people](#)

Los Angeles Times Homicide Map [edit](#) / [delete](#)
to maps statistics visualization infobiz interaction news data ... [saved by 63 other people](#) ... on aug 14

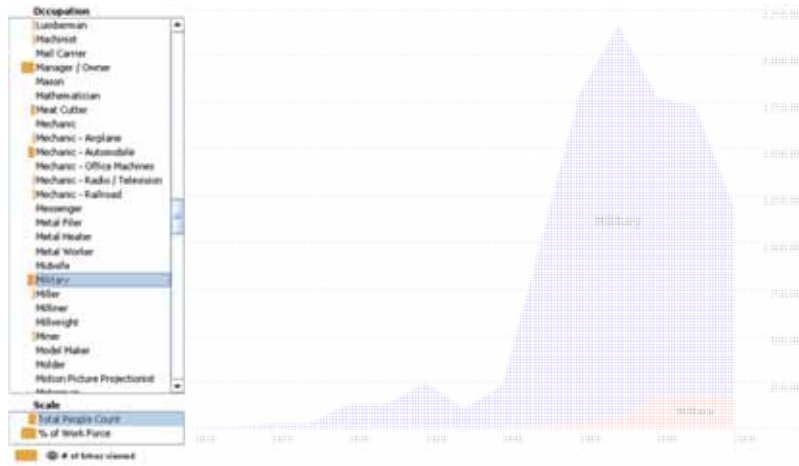
< earlier | later > page 1 of 19

Read & Edit Wear, Hill et al 1992



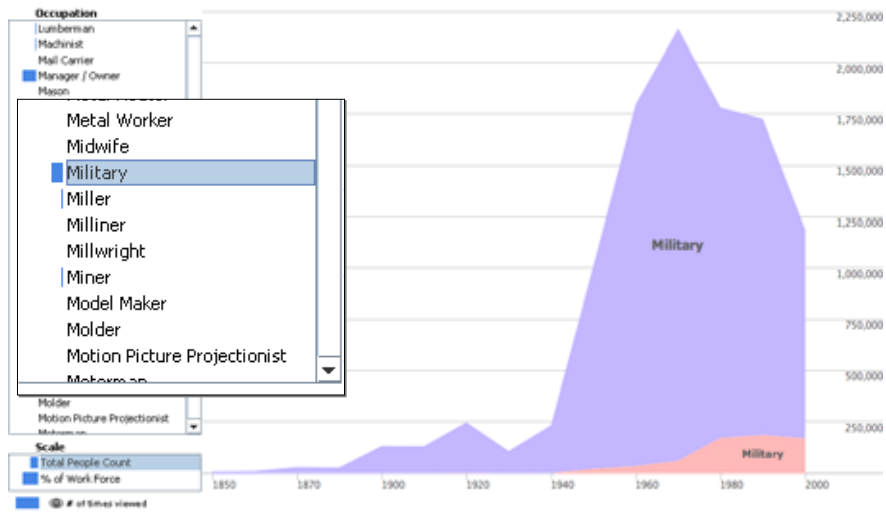
Wattenberg & Kriss – Color by history: grayed out regions have already been visited

Scented Widgets [InfoVis 07]

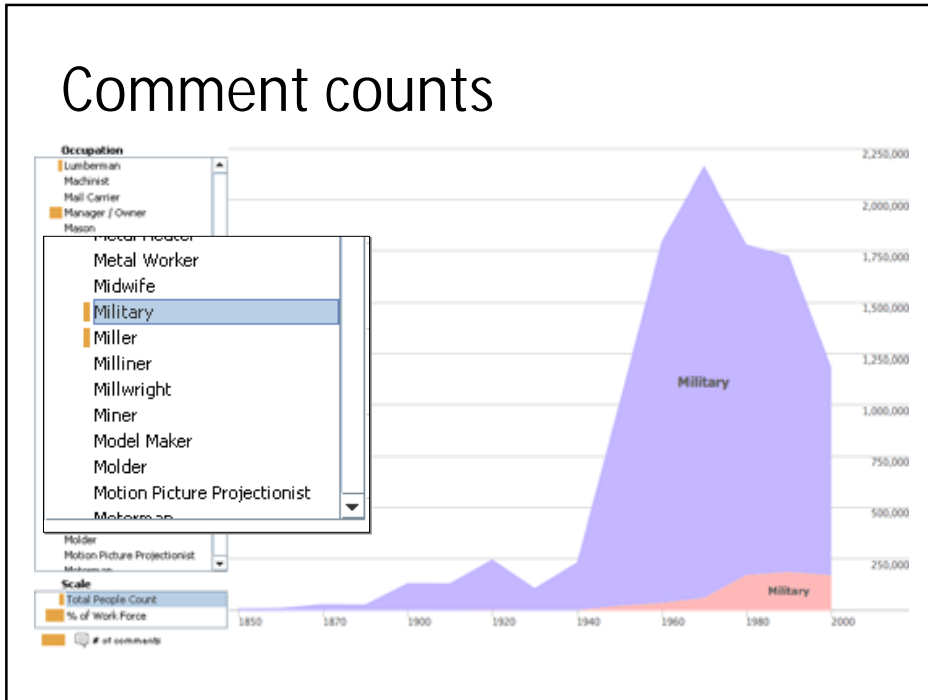


Visual navigation cues embedded in interface widgets

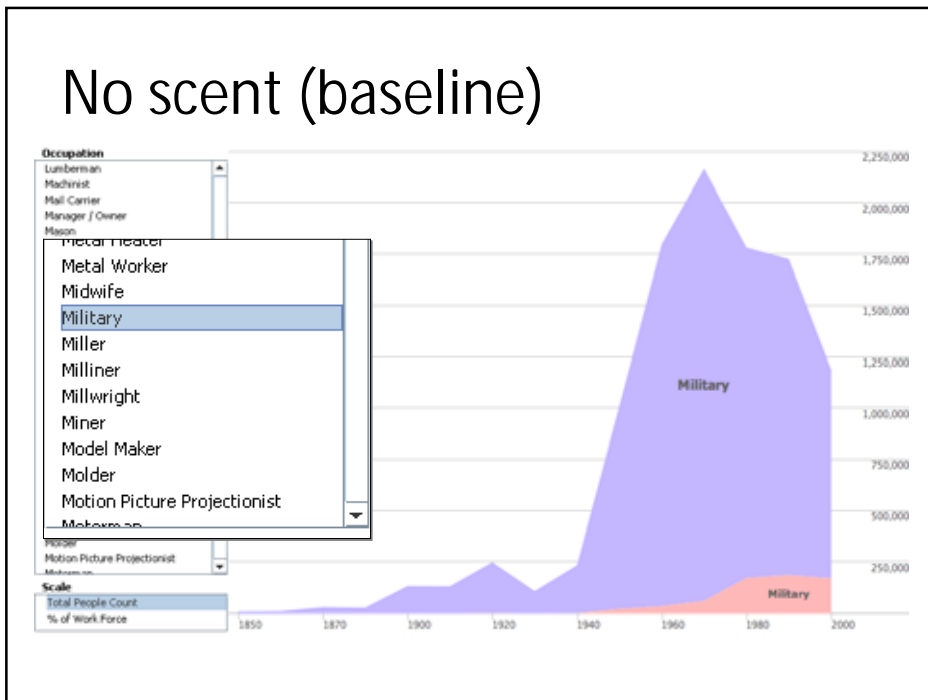
Visitation counts



Comment counts



No scent (baseline)



Do social activity cues affect usage?

Hypotheses: With activity cues, subjects will

1. Exhibit more revisitation of popular views
2. Make more unique observations

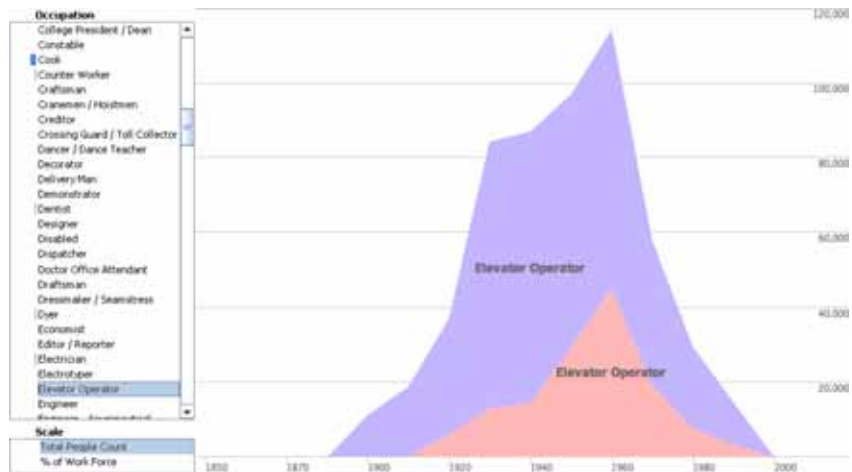
Controlled experiment with 28 subjects

Collect evidence for and against an assertion

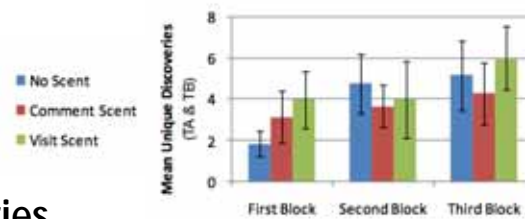
Varied scent cues (3) and foraging task (3)

Activity metrics collected from sense.us study

“Technology is costing jobs by making occupations obsolete.”



Results



Unique Discoveries

Visit scent had sig. higher rate of discoveries in first block. Less reliance on scent when subjects were familiar with data and visualization.

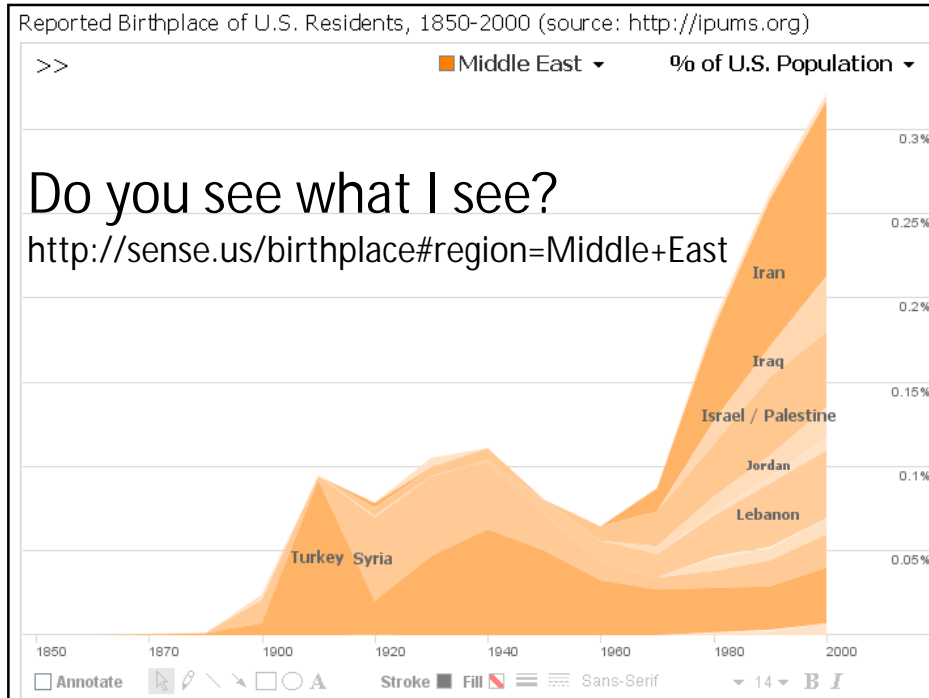
Revisitation

Visit and comment scent conditions correlate more highly with seed usage than no scent.

Social Data Analysis

How can users' **activity traces** be used to improve collaborative analysis?

How should **annotation techniques** be designed to provide nuanced pointing behaviors?



Common Ground

Common Ground: the shared understanding enabling conversation and collaborative action [Clark & Brennan '91]

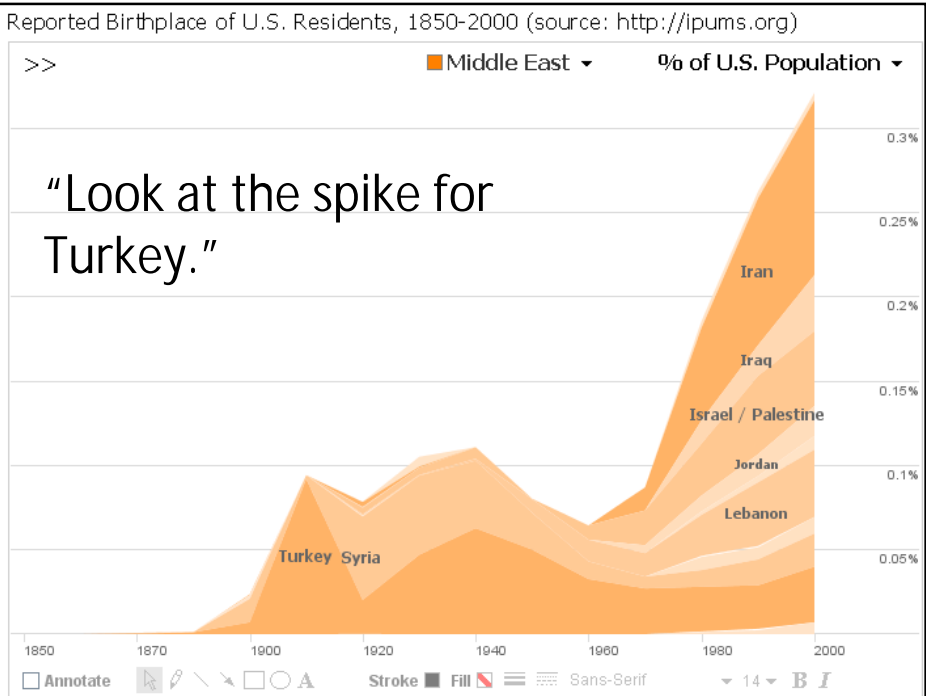
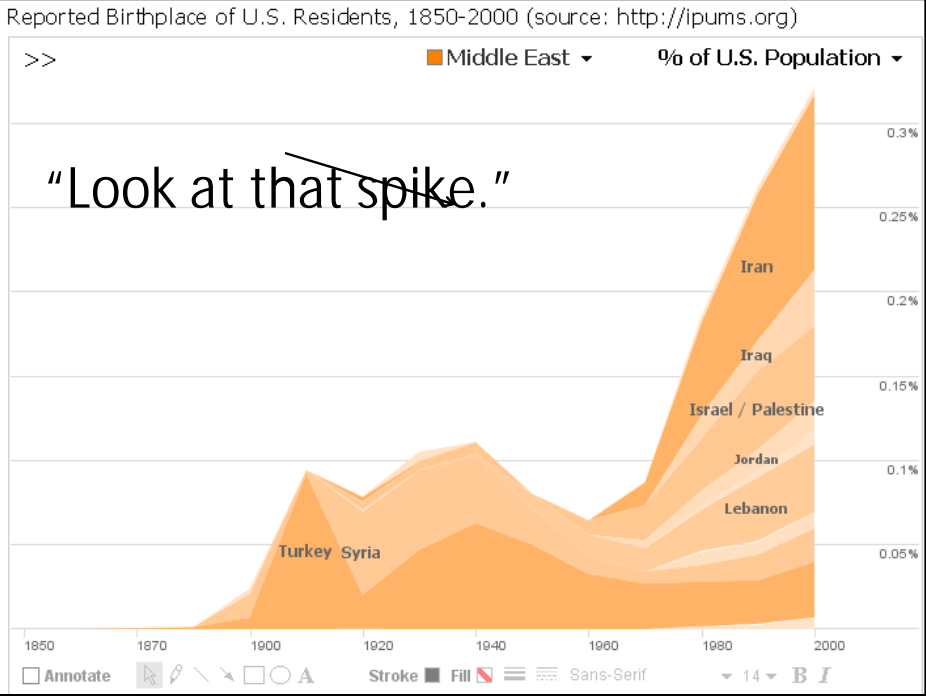
Do you see what I see? → View sharing (URLs)

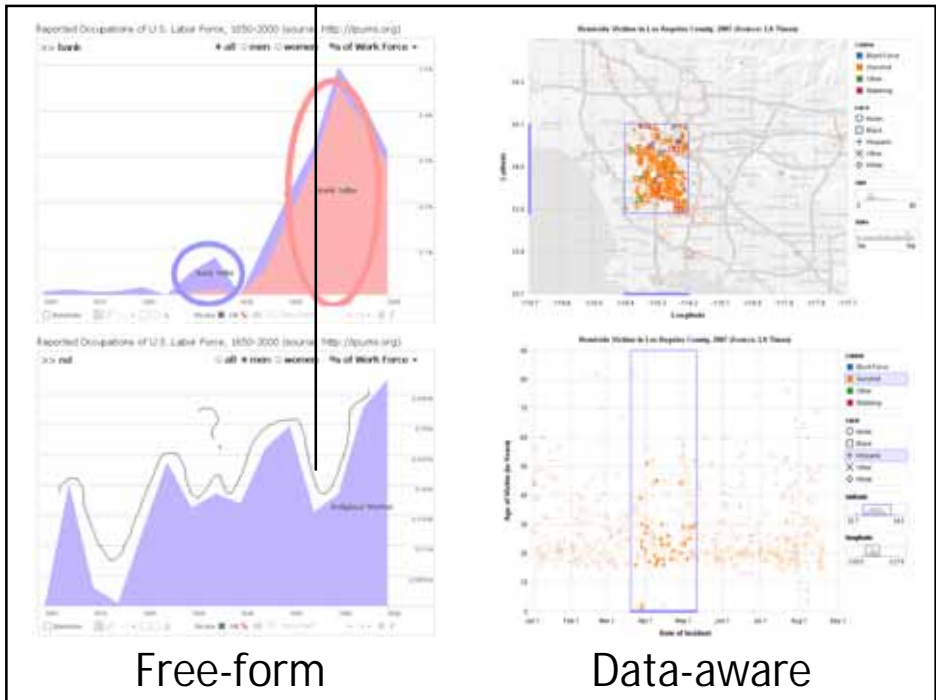
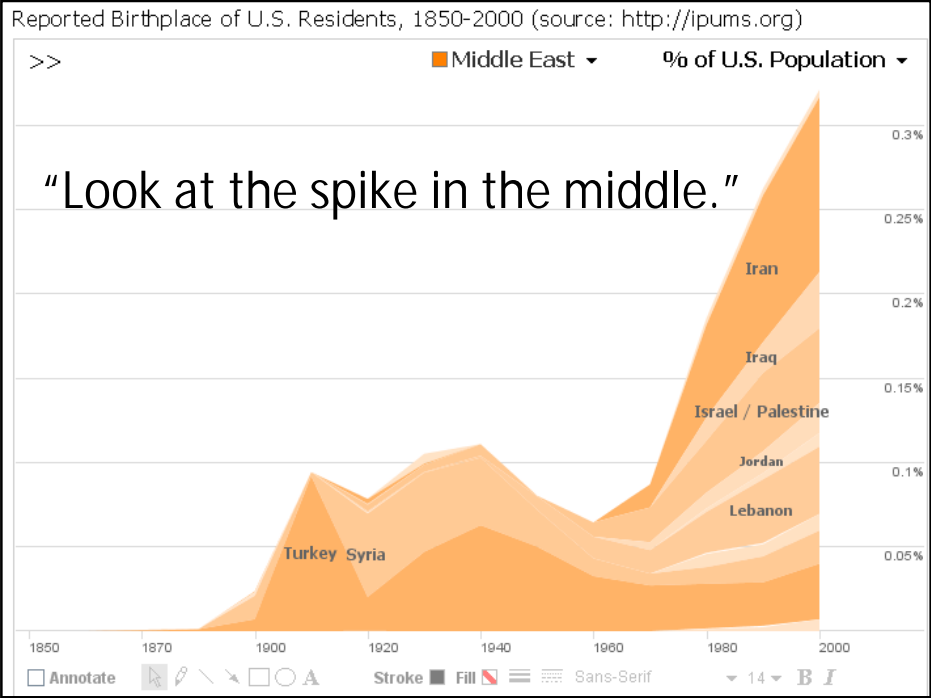
How do collaboration models affect grounding?

Linked discussions vs. embedded comments vs. ...

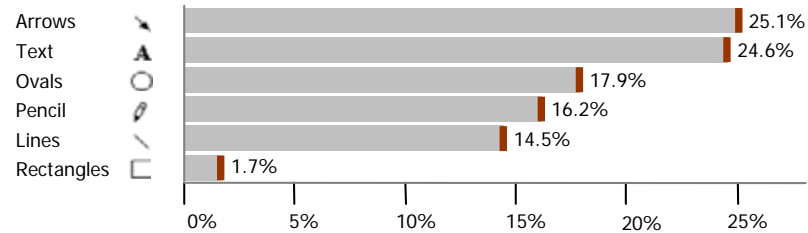
Principle of Least Collaborative Effort: participants will exert *just enough* effort to successfully communicate.

[Clark & Wilkes-Gibbs '86]





Use of Annotations



39.0% of comments included annotations

Pointing to specific points, trends, or regions (88.6%)

Drawing to socialize or tell jokes (11.4%)

Variety of subject responses

'Not always necessary', but 'surprisingly satisfying'

Some concern about professional look

Visual Queries

Model selections as **declarative queries** over interface elements or underlying data



$(-118.371 \leq \text{lon} \text{ AND } \text{lon} \leq -118.164) \text{ AND } (33.915 \leq \text{lat} \text{ AND } \text{lat} \leq 34.089)$

Visual Queries

Model selections as **declarative queries** over interface elements or underlying data

Applicable to **dynamic, time-varying data**

Retarget selection **across visual encodings**

Support **social navigation and data mining**

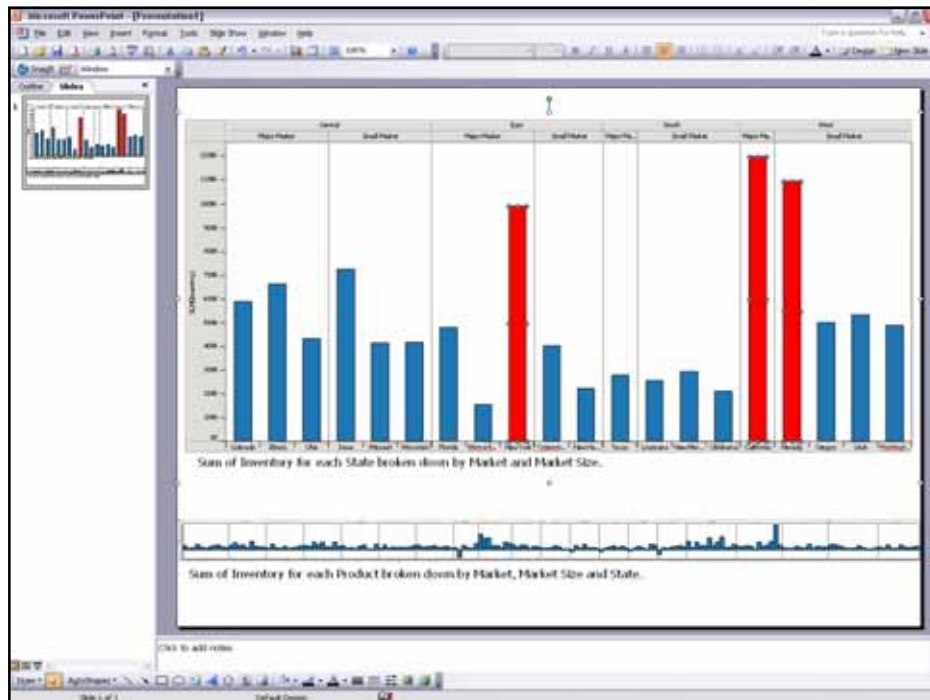
Social Data Analysis

How can users' **activity traces** be used to improve collaborative analysis?

How should **annotation techniques** be designed to provide nuanced pointing behaviors?

How can interface design better support **communication of analytic findings**?

Graphical Analysis Histories



Social Data Analysis

How can users' **activity traces** be used to improve collaborative analysis?

How should **annotation techniques** be designed to provide nuanced pointing behaviors?

How can interface design better support **presentation of analytic findings**?

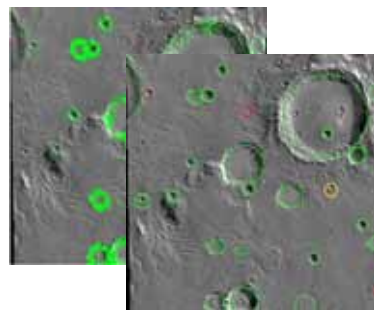
How can user contributions be **better integrated**?

Structured Conversation

Reduce the cost of synthesizing contributions

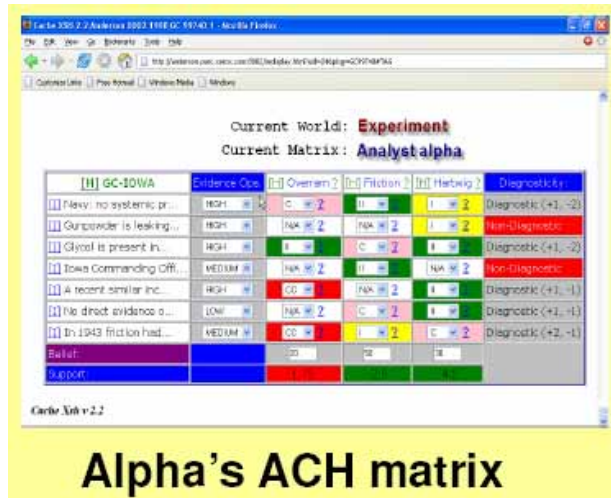


Wikipedia: Shared Revisions

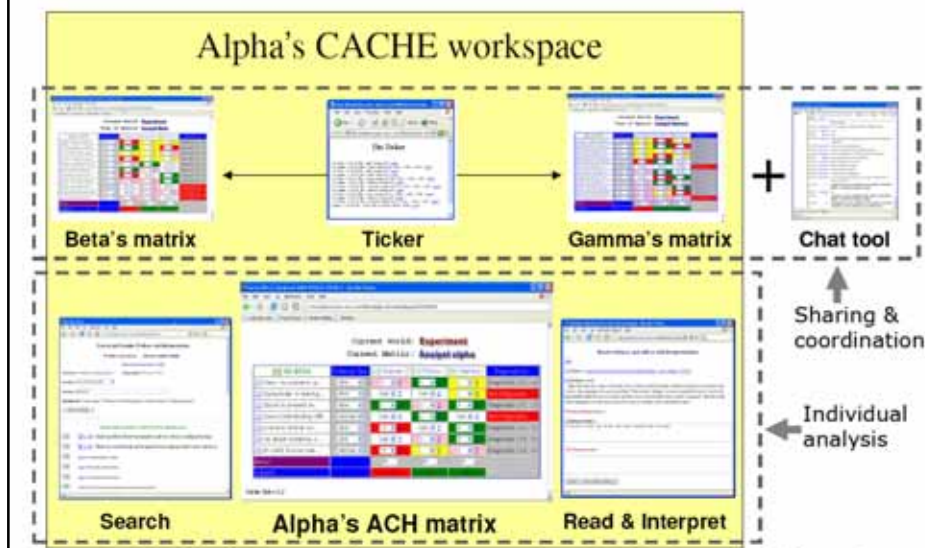


NASA ClickWorkers: Statistics

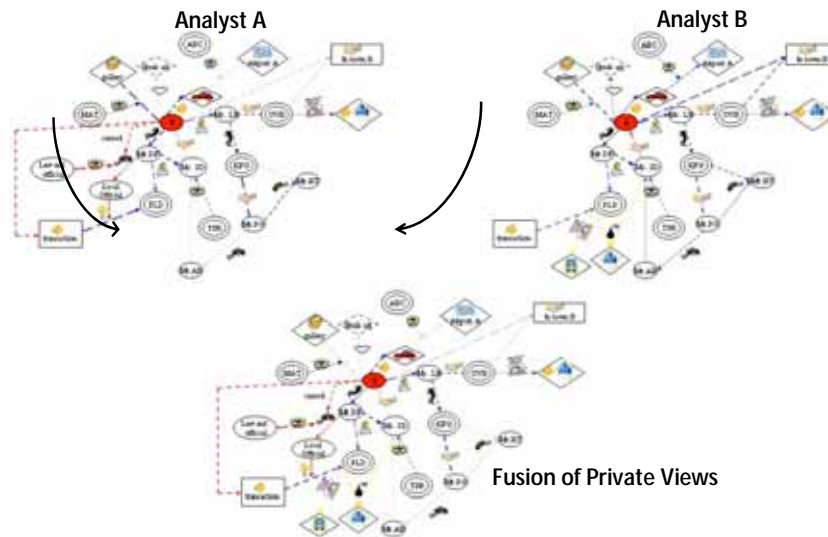
Integration: Evidence Matrices (Billman et al '06)



Integration: Evidence Matrices (Billman et al '06)



Merging Analysis Structures (Brennan et al '06)



Design Considerations [VAST 07, IVS 08]

- Division, allocation, and integration of work
- Common ground and awareness
- Reference and deixis (pointing)
- Identity, trust, and reputation
- Group formation and management
- Incentives and engagement
- Presentation and decision-making

Summary

As visualization becomes a citizen of the web, opportunities for collaborative analysis abound

Challenges

Weave data visualizations into the web: data access, visualization creation, view sharing and pointing

Support discussion and discovery, but also the integration of contributions to leverage the collective

We need improved processes and technologies for communication and dissemination